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POULTRY DISEASE IN PUBLIC HEALTH. REVIEW FOR EPIDEMIOLOGISTS

Mildred M. Galton, et al

Communicable Disease Center
Atlanta, Georgia

1960

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POULTRY DISEASES in PUBLIC HEALTH

REVIEW for EPIDEMIOLOGISTS

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE

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U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE, Communicable Disease Center
Epidemiology Branch, Veterinary Public Health Section
Atlanta, Georgia

ERRATA SHEET

Poultry Diseases in Public Health
by
Mildred M. Galton, Sc.M., and Paul Arnstein, D.V.M.

In the last footnote to Table 1, page 7, the abbreviation should be NOVS.

On page 10, 1st paragraph, 9th line, and in reference 86 on page 31, H. Williams Smith is the author, not H. W. Smith.

Reference 147 should refer to page 330; reference 149 should refer to page 336; reference 152 should refer to page 353.

POULTRY DISEASES
in
PUBLIC HEALTH

REVIEW for EPIDEMIOLOGISTS

By
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and
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Epidemiology Branch

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
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FOREWORD

The amazing increase in poultry populations throughout the world has focused attention on them as reservoirs of disease, both animal and human. This review has been prepared by Galton and Arnstein in response to the numerous inquiries continually being made as to the role of poultry in disease outbreaks.

In the United States, domestic fowl are the most frequently identified vehicle of dissemination in outbreaks of food-borne infections, and the salmonellas, followed by the paracolons (Arizona group), are the most important organisms implicated in these outbreaks. While considerable progress has been made during the past 25 years in the control of salmonellosis in various types of poultry, there is need to intensify this effort further.

Recent work by European and American investigators has incriminated feeds containing fish meals that originate in tropical countries as a frequent source of disease outbreaks in both poultry and animals, which in turn have served as a source of human infections. Hence the control of disease extends far beyond the efforts of national agencies and becomes truly an international problem. Many countries of the world are now attempting to control the dissemination of disease through animal feeds by requiring that ingredients be pasteurized or sterilized and by encouraging measures to prevent subsequent contamination. Such procedures will prevent further spread of pathogens that are known to produce food-borne outbreaks with this origin.

Diseases due to many bacteria other than the salmonella and paracolon groups are reported in poultry, and some – e.g., those caused by *Listeria*, *Pasteurella*, and *Erysipelothrix* – may be the source of occasional human infections. On rare occasions *Mycobacterium avium* has been found to produce disease in man. Staphylococcal and streptococcal organisms are not infrequently found in birds, but infection in man from this source appears to be uncommon. Botulism is relatively rare in large commercial flocks, and so far as can be determined, poultry has not been found to be a source of the disease in man. The diphtheria organism has been reported in fowl but there is little or no evidence of any public health significance. Still other bacterial diseases are associated with poultry processing, but fowl cannot be considered as reservoirs. One such disease is leptospirosis. It is commonly found in rodents; so their *control in and around poultry plants is essential* to prevent contamination of poultry products.

Identification of some of the viral diseases in birds, and of certain arthropods – e.g., mosquitoes, ticks, and mites – as vectors has given additional significance to domestic poultry as probable secondary hosts or reservoirs. In many areas of the world the arthropod-borne encephalitis viruses may cause clinically inapparent infection in most poultry and wild birds. However, in domestic pheasants eastern encephalitis virus causes clinical disease with high mortality. Thus these birds may provide warning of the presence of this disease in an area. Kissling has suggested that surveillance for infection in English sparrows, pigeons, and other such birds would probably show that they, also, can furnish warning of an incipient epidemic in humans and horses.

The psittacosis-LGV group of viruses is one of the most widespread in nature, being found in many species of birds and animals, as well as in humans. Some strains are host-specific, but others, including those found among the psittacine birds and domestic fowl, produce overt disease in man. Control of psittacosis, or ornithosis, as a human health problem is dependent upon its control in bird species that have a close relation to man. The advent of the broad-spectrum antibiotics has made possible a degree of control, but there is also a need for more effective immunization procedures. In recent years the disease among workers in poultry processing plants, already infrequent, has been further minimized where adequate ventilation has been provided. This practice has worked well both in the United States and in Europe in areas where ornithosis has been an occasional problem.

Newcastle disease, in contrast to the viral encephalitides and psittacosis, has its basic reservoir in poultry. Since it is recognized occasionally among farmers, poultry vaccinators, veterinarians, and poultry processing-plant employees, the use of vaccines in persons subject to such exposure should be studied. An interesting observation is that the milder the organism strain the broader the host spectrum. As an example, the Asiatic strains, which are considered the most virulent seldom affect man.

Some fungal and parasitic diseases are reviewed but so far as can be determined, poultry do not play an important role as sources of these infections for man.

This review has been developed as a guide to epidemiological workers and should not be considered as a definitive work. An investigator interested in specific problems should refer to textbooks and current published articles on poultry diseases. It is the aim of the Communicable Disease Center to bring this review up-to-date periodically.

James H. Steele, Chief
Veterinary Public Health Section

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INTRODUCTION

Poultry, especially chickens (*Gallus domesticus*), are by far the most numerous species of domestic animals. For example, on January 1, 1957 the Department of Agriculture estimated that there were 392,811,000 chickens on U. S. farms *(1)*. In addition there were about 200 million more in commercial broiler producing establishments or a total of about 600 million chickens. The total of all types of cattle, the next most numerous species, was estimated at 95,166,000. Because of certain biologic characteristics – especially their gregariousness, omnivorous diet and suitability as symptomatic or asymptomatic hosts to a variety of pathogens – fowls constitute a widespread reservoir of potential human infections, infestations and intoxications.

It is the purpose of this review to discuss and evaluate some of the reported outbreaks and sporadic cases of human diseases traceable to this reservoir. Although not complete, it is hoped that this review will provide a stimulus to others in the field of communicable disease control and poultry hygiene to add further data of their own.

Man may acquire diseases from fowls and poultry products by the following principal means: (a) Ingestion of raw, inadequately cooked or improperly handled poultry meat or egg dishes originating from infected birds; (b) Contact with infected fowl, including skin, wound or conjunctival contamination, inhalation of pathogens, and accidental ingestion. These are usually occupational exposures on farms, in slaughtering establishments, hatcheries, dressing plants and markets; (c) Ingestion of meat or egg dishes derived from noninfected fowl, but subsequently contaminated by handlers, dirt, vermin, or similar factors.

Category (c) will not be considered in detail because it is not peculiar to poultry products but is rather a serious public health problem involving most perishable foods. It should be noted, however, that poultry flesh, viscera, tissue fluids, and eggs constitute an unusually favorable substrate for the proliferation or maintenance of a variety of pathogens.

Fowl diseases to which man is also susceptible comprise a rather large group including those caused by bacteria, viruses, fungi and protozoa *(2,3,4,5)*.

This report reviews the current public health aspects of the following diseases involving man and fowls:

Bacterial: Salmonellosis, paracolon infections, erysipelas, staphylococcal infections, streptococcal infections, tuberculosis, brucellosis,

listeriosis, tularemia, pasteurellosis, pseudotuberculosis, diphtheria, anthrax, botulism, and leptospirosis.

Viral: Equine encephalomyelitis, Newcastle disease and ornithosis-psittacosis.

Fungal: Favus, thrush, aspergillosis, and histoplasmosis.

Parasitic: *Dermanyssus gallinae*, toxoplasmosis.

BACTERIAL DISEASES

Salmonellosis

The role of fowl, swine, cattle and many other animals as a source of outbreaks of salmonellosis in man has been established, but only during the past decade has great emphasis been placed upon the public health significance of these reservoirs in the epidemiology of salmonella infections. There have been numerous reports incriminating poultry or poultry products in outbreaks of the disease in man. The studies of Edwards, Bruner and Moran *(6)* and Edwards *(6a)* indicate that fowls are the largest single reservoir of salmonella in this country. While *S. pullorum* and *S. typhimurium* are the most common types, these authors found a greater number of salmonella types in fowl than any other species except man. The majority of these have been found also in humans. As pointed out by Hinshaw and McNeil *(7,8)* "there may well be no truly avian nor truly human types; in fact such a description frequently means only priority in isolation." They observed *(9)* seven cases of salmonella gastroenteritis among attendants on poultry farms caused by contact with infected poultry. Further evidence indicated that transmission of salmonella from human carrier attendants to fowl also occurred. All types are potentially pathogenic for man, animals and fowls. In poultry as in man *(10,11)* and other animals *(6)* severity of salmonella infection depends largely upon age and general resistance rather than upon the type of salmonella, the young appearing most susceptible. *S. pullorum* until recently considered relatively nonpathogenic for man has been incriminated as the cause of several outbreaks of food poisoning *(12,13,14)* and several sporadic cases *(15,16)* involving approximately 450 patients in all. In Florida *(17)*, *S. pullorum* has been isolated from cases of mild enteric fever and gastroenteritis in three persons.

Considerable evidence is accumulating concerning the presence of salmonella in poultry meat. Cherry, Barnes and Edwards *(18)* report the recovery of a monophasic salmonella from the skin of frozen turkeys. Galton, *et al. (19)* isolated *S. anatum* from material appearing to be encysted egg yolk in a frozen chicken. Schneider and Gunderson *(20)* found four salmonella types on the skin of 4.4 percent of 1,014 eviscerated chickens. They concluded that the customary methods of sanitation in the plant did not eliminate salmonella. Most of these birds had been frozen and stored for some time. Browne *(21)* found that *S. typhimurium* survived for at least 13 months on the skin of frozen turkeys. It is thus apparent that freezing does not kill all of the salmonella.

In Canada, Abelseth and Robertson *(22)* have observed an apparent increase in mortality of turkey flocks due to *S. typhimurium*. They reported a human outbreak of *S. typhimurium* infection involving a family of seven following the handling of infected poults and point out that this may be an increasing public health hazard. Several States have recently initiated a testing service for the control of *S. typhimurium* infection in turkeys.

More recently, attention has been given to the study of salmonella in the environment of poultry processing plants. Browne *(21)* studied a turkey processing plant and isolated *S. typhimurium* from trays on which viscera were placed, pans in which cleaned giblets were stored, waste buckets and hands of eviscerators, trimmers and inspectors. These organisms were also obtained from the loading platform, scalder chute, and floor, from the final wash trough and even from dust on the rafters.

Galton, *et al. (19)* studied three poultry processing plants in Florida. In all, 1,244 cultures were taken from materials in the plants, and 196 (16 percent) were positive for salmonella. The highest percentage of positive findings was from edible viscera and the table on which edible viscera were wrapped. They found 13 (11 percent) positive from 118 swabs from tubs holding iced birds ready for market. The organisms on these contaminated birds preserved by refrigeration would reach the kitchens and the hands of cooks and thus provide a ready source of salmonellosis in man.

A recent large outbreak in Georgia reported by McCroan (23) was due to *Salmonella blockley* in commercially prepared chicken salad. There were approximately 300 confirmed cases and an estimated 3,000 others who developed clinical symptoms. Another large outbreak in a Federal institution in Georgia was due to *S. typhimurium* in cold sliced turkey *(24)*. Investigation revealed that the frozen turkeys were infected with *S. typhimurium*. While the organisms were destroyed by roasting, the cooked meat was contaminated when sliced on the same chopping block used to cut and prepare the raw turkeys for roasting. *S. typhimurium* was isolated from 100 patients and approximately 200 others developed clinical symptoms.

During an extensive study of the bacteriology of commercial poultry processing, Kyle, McFadden and Gunderson *(25)* isolated salmonella from the hands of workers on the evisceration line, from the skin of birds ready for storage, from organs of the chickens and other items on the evisceration line.

Reports implicating raw, frozen or dried eggs as sources of salmonella outbreaks appear frequently. Watt *(26)* reported such an outbreak attributed to raw eggs which contained *S. montevideo*. *S. tennessee* was isolated from frozen whole eggs and from powdered eggs by Schneider *(27)*. Gibbons and Moore *(28)* found salmonella in 5.7 percent of 317 samples of Grade A Canadian dried whole egg powder and in 15.8 percent of 63 Grade B samples.

Abramson *et al. (29)* recovered *Salmonella montevideo* from the stools of 10 of 13 infants who developed fever and acute diarrhea after ingesting egg-yolk powder. Extensive studies on the occurrence of salmonella types in dried egg powder have been reported by Schneider *(30)*, Solowey *et al. (31)*, and the British investigators *(32,32a)*. Further studies on heat resistance and destruction by pasteurization of salmonella isolated from spray dried or liquid whole eggs have been reported by Solowey *et al. (33)*, Winter *et al. (34,35)* and Goresline *et al (36)*. The investigation carried out by Goresline *et al.* revealed that pasteurization can be used successfully, under processing plant conditions, to produce liquid, frozen, and dried whole eggs free of salmonella. They recommend flash heating the liquid whole egg to 140° F and holding at that temperature for three minutes to kill any salmonella present.

That breaks in the pasteurization procedure do occur in large processing plants is indicated by an announcement made in 1952 by the Food and Drug Administration wherein the public was warned to discontinue use of a certain brand of dried egg yolk due to the presence of salmonella. This product had been pasteurized.

In England, public health authorities *(37)* have observed that the incidence of human salmonellosis has doubled during the past few years. Dried and liquid egg imports are considered the prime cause of this increase; 5 to 29 percent of these products sampled during 1957 were found infected with salmonella. The distribution of serotypes isolated from these products and from human cases in the United Kingdom was very similar. Imported egg products in Germany during 1956 have also been found contaminated with salmonella *(38)*.

Osborne, Straka and Lineweaver *(39)* and Anellis, Lubas and Rayman *(40)* studied the heat resistance of certain strains of salmonella. In general the type of salmonella was less important than the resistance of individual strains. These investigators also noted that pH of the medium influenced rate of destruction. Heat resistance was considerably greater in an acid medium. Husseman and Wallace *(41)* investigated the survival of salmonella in roasted and broiled chickens. A series of birds were inoculated intravenously with suspensions of viable *Salmonella pullorum* or *Salmonella typhimurium* then slaughtered and eviscerated according to usual procedures. They were either broiled or roasted depending upon size, by "methods currently advised by home economists." Muscle tissues and edible organs were then cultured. Although the count was greatly reduced by both cooking processes, viable salmonella were recovered from all tissues in every bird.

McCullough and Eisele *(42)* were able to produce clinical salmonellosis in 32 human volunteers by experimental infection with strains of *Salmonella meleagridis* and *Salmonella anatum* derived from spray dried whole eggs. Similar studies *(43)* with *S. newport, S. derby* and *S. bareilly* resulted in clinical illness in 15 subjects, and with 4 strains of *S. pullorum (44)* there were 27 cases of human illness.

It is thus obvious, as emphasized by Hinshaw and McNeil *(7)* that "both from a poultry economic and public health standpoint, salmonellosis is a hazard which should be eliminated." These investigators present the following essentials for prevention of the disease in poultry: "(1) elimination of known infected flocks as sources of replacements for breeding flocks, (2) the use of separate hatching facilities for eggs from such flocks, (3) the frequent use of diagnostic laboratories to discover new outbreaks which may endanger future replacement sources, (4) the recognition of numerous animal reservoirs of these diseases which must be controlled to prevent transmission, (5) fly control, and (6) cooperation of growers, hatcheries, veterinarians, and State agencies in securing replacements from salmonellosis free sources."

At the present time, salmonellosis remains an important enteric disease of man throughout the world. Wherever concerted efforts are applied to collect statistical data, the incidence appears on the rise.

The occupational hazard to persons engaged in poultry raising and processing is well delineated by the widespread infection in fowl and man's susceptibility to the same salmonella types. The more important problem of infection by consumption in the household, public eating place, institution, or gathering is more difficult to outline precisely because of possibilities of contamination by human carriers as well as original infection in food producing animals. The frequency of salmonella in eggs and in fowls, the ability of the organisms to survive some of the commercial and culinary processes and the predominance of poultry dishes as vehicles of reported outbreaks point to poultry and poultry products as an important source of salmonellosis in man. While many cases probably do not come to the attention of public health authorities, reported outbreaks are numerous as shown in table 1.

Paracolon Infections

The significance of the etiological relationship between paracolon organisms and enteric infections in man is difficult to determine due to the frequent recovery of some of these strains from the feces of apparently healthy persons and the lack of adequate methods of classification of different types. However, there have been numerous reports *(10,11,45, 46)* indicating pathogenicity of some types.

Many of the paracolon organisms contain antigens common to the salmonella and shigella groups. This is particularly true of the Arizona group of paracolons which is closely related to the salmonella. The excellent work of Edwards and his co-workers *(47,48,49,50)* in establishing a satisfactory serologic classification for the Arizona group and presentation of epidemiological data leaves no doubt that they are pathogenic for animals. The majority of cultures of this group that have been studied were isolated from fowls, egg powder, and reptiles. Many cultures were obtained by Hinshaw and McNeil *(51,52)* during studies of

Table 1

REPORTED OUTBREAKS OF SALMONELLOSIS ATTRIBUTED TO POULTRY OR POULTRY PRODUCTS 1951-1959

Year	States	Outbreaks	Cases	No. of Salmonella Types
1951	4	7	471	4
1952	7	8	159	6
1952*	14 & D.C.	–	68	1
1953*	17 & D.C.	–	45	1
1953	6	7	383	8
1954	3	8	606	8
1955	5	7	218	7
1956	5	6	3,308	9
1957	4 & D.C.	12	509	6
1958	4	4	454	4
1959	7	13	581	7

* Scattered cases due to dried canned egg yolk.

** Outbreak in Georgia accounted for 3,000 cases due to *Salmonella blockley* in a commercially produced chicken salad.

National Office of Vital Statistics (NOVIS)

infections among reptiles and turkeys. The symptoms and pathology in birds infected with the Arizona paracolon are comparable to those which occur in salmonellosis in fowls. The organisms have been isolated from heart, blood, and all organs, indicating a definite septicemia; young fowls, particularly poults, appear more susceptible. Mortality in flocks was comparable to that found in salmonella infections. The spread of the infections by hatcheries and through eggs has been clearly established *(50,51,53).*

There have been scattered reports of the isolation of Arizona paracolon bacilli from man. Of 456 cultures studied by Edwards, West and Bruner *(50)* five were from human sources. All were from cases of enteric infection in which no other pathogenic organisms were recognized. Verder *(54)* isolated a paracolon identified by Edwards as Arizona 1,2:1,2,5 from 70 percent of patients cultured during an outbreak of gastroenteritis involving 51 student nurses. The organism was not obtained from 16 normal students cultured. Buttiaux and Kesteloot *(55)* reported the isolation of paracolon bacilli similar to the Arizona group from six patients, three with acute enteric disease, two with chronic colitis and one with a typhoid-like illness. In 1950, Murphy and Morris *(56)* described two small outbreaks of gastroenteritis, both associated

with a member of the Arizona paracolon group. In both episodes, evidence relating to source of infection, incubation period, and symptoms of individuals involved resembled the pattern observed in food infections due to salmonella. Bacteriological findings indicated the paracolon bacillus was the etiologic agent.

More recently, Edwards *(57)* has reported on the occurrence of Arizona paracolons in man. Of 87 cultures isolated from man, 23 were obtained from blood or localized infections, 56 from diarrhea, gastroenteritis and enteric fever and only 8 from asymptomatic persons. More than 50 percent of the cultures belonged to 2 serotypes, 7:1,2,6 and 10:1,2,5.

The Kentucky State Department of Health reported to the National Office of Vital Statistics, January 19, 1957, an outbreak of gastroenteritis affecting 650 of 950 persons eating in a high school cafeteria. Boiled turkey was the food epidemiologically implicated as the cause of the outbreak. The dinner was prepared from frozen turkeys. They were cooked inadequately, according to the investigators, and from one turkey which was not used in the preparation of the meal and was still frozen, paracolon organisms of the Arizona group were isolated. A similar outbreak was reported to the National Office of Vital Statistics by the New Mexico Health Department for the week ending January 26, 1957. Of 519 children and teachers in a school, 323 became ill from two to ten hours after a lunch of turkey and dressing. Bacteriologic examination of turkey meat revealed a heavy growth of a paracolon organism, possibly of the Arizona group. The same organism was also found in stool specimens from three of the patients.

The frequent isolations of paracolons from ill or well fowl, as well as from cases of human gastroenteritis, certainly constitute strong evidence that poultry is a very prominent reservoir of paracolons pathogenic to man. The few well documented outbreaks of human gastroenteritis known to have been caused by ingestion of poultry meat should serve as a stimulus for further and more intensive efforts to trace original sources of gastroenteritis caused by paracolons.

At least one report has appeared in which an Arizona paracolon was isolated from human sources other than feces. In this case the organisms were recovered from the ear of a child with otitis media *(58)*.

Erysipelas

The occurrence of a septicemia associated with *Erysipelothrix rhusiopathiae*,* the causative agent of swine erysipelas and erysipeloid infection in man, has been reported in many species of birds. The disease

* The name of *Erysipelothrix rhusiopathiae* has been changed to *Erysipelothrix insidiosa* according to Bergey's Manual of Determinative Bacteriology, Seventh Edition, 1957.

is relatively common in turkeys and ducks *(59,60,61,62)*. It is characterized in acute cases by febrile symptoms, occasionally diarrhea and gradual emaciation *(63)*. Diagnosis depends upon bacteriological examination as lesions are indefinite and not usually considered pathognomonic.

Erysipelas in chickens on the other hand has been rarely reported in North America. Vance and Whenham *(64)* reported an outbreak they observed in Canada. The disease is described as causing sudden deaths with mortality up to 65 percent, especially in younger animals. They also list eight previous outbreaks, four in the United States and four in Canada. One outbreak in geese has also been reported from Canada *(65)* and in farm raised pheasants *(66)*.

The infection in man, first recognized by Rosenbach in 1884, may occur as a mild, localized cutaneous lesion, sometimes accompanied by mild arthritic symptoms, as a diffuse or generalized cutaneous eruption, with arthritic symptoms and negative blood culture, or as a septicemic form with endocarditis *(67)*. Chronic cases of long duration have also been reported *(68)*.

Erysipeloid has long been recognized as an occupational disease of abattoir employees, veterinarians, butchers, kitchen workers and those handling poultry and fish *(69)*. In a review of 100 cases Klauder *(70)* was able to obtain a history of contact with animals, animal products or fish. In southern Illinois, three members of a farm family showed typical lesions of erysipeloid concurrently with an outbreak of erysipelas among their turkeys. *E. rhusiopathiae* was isolated from human lesions and turkeys *(71)*. Stiles *(59)* reported cutaneous lesions and symptoms of erysipeloid in the owners of an infected turkey flock. Successful treatment of the disease in man with penicillin has been reported frequently *(68,72,73)*. Stiles considered the public health significance of marketing possibly infected turkeys and outlined the procedure followed in an outbreak in one flock. Apparently healthy fowls were marketed to a processing plant where they were subjected to Federal inspection. Questionable birds were rejected and the slaughtered birds were boned and sterilized by canning.

According to Klauder *(70)*, the virulence of *E. rhusiopathiae* varies in different species and in the same species. The organism has the capacity to change suddenly from a harmless saprophyte to a pathogenic parasite. Although man is relatively immune when the organism enters the gastrointestinal tract, cutaneous infections appear rather commonly. Skalova *(74)* in Yugoslavia has reported one fatal case of infection with *E. rhusiopathiae*.

The elimination of *E. rhusiopathiae* infection from poultry flocks appears quite possible using available eradication techniques such as quick disposal of infected flocks and strict sanitation on poultry farms, especially in view of successful control procedures applied to swine erysipelas. Until this goal is attained, a potential occupational hazard of erysipeloid infection will continue to exist in poultry raising and processing establishments.

Staphylococcal Infections

Staphylococci are widely distributed in nature and they may cause a variety of disease entities in man, domestic animals and fowl *(75)*. Avian staphylococcosis has been reported in turkeys by Jungherr *(76)*, Hinshaw and McNeil *(77)*, Hinshaw *(78)* and Fahey *(79)*, in geese by Lucet *(80)*, in ducks by Van Heelsbergen *(81)*, and less frequently in chickens *(82, 83,84)*. In fowl the infection occurs as an acute septicemia or chronic arthritis also known as bursitis, hock disease, ostitis or synovitis. Some strains of staphylococci isolated from these conditions were penicillin resistant *(85)*. H. W. Smith *(86)* has produced the disease in chickens by intravenous injection.

In man, the most frequent manifestation is gastroenteritis produced by an enterotoxin liberated by the growth of some staphylococcus strains in food prior to ingestion. Outbreaks of gastroenteritis following ingestion of poultry dishes are reported frequently (table 2), and the majority of these are of staphylococcal origin. Septicemia occurs occasionally in man. Although no reports have been found concerning the transmission of fowl staphylococcosis to humans, McNeil *(87)* states that they have isolated *Micrococcus pyogenes* from boils on the hands of workers in poultry killing plants. Dermatitis due to staphylococci was encountered in hatchery workers by the University of Utah School of Medicine *(88)*. This potential source of infection in man warrants further study.

Table 2

REPORTED OUTBREAKS OF GASTROENTERITIS ATTRIBUTED TO POULTRY OR POULTRY PRODUCTS 1951-1959

Year	No. of Outbreaks	No. of Cases	No. of States
1951	12	1,031	6
1952	8	298	7
1953	51	4,066	18
1954	43	1,965	15
1955	15	716	14
1956	25	1,803	12
1957	19	1,491	10
1958	18	1,480	10
1959	42	1,789	16

(NOVS)

Streptococcal Infections

Streptococcal infections occur in both man and birds. Ingalls *(2)* was of the opinion that the infection in poultry does not play a prominent part in human disease; however, he has observed that the handling, dressing or eating of infected birds may serve as a source of infection in man. Acute streptococcic septicemia in fowls was first observed in this country by Norgaard and Mohler, 1902 *(89)* and later by Hudson *(90)*. The disease is highly fatal. A chronic infection of hens due to hemolytic streptococci (group C) was reported by Edwards and Hull *(91)*. Buxton *(92)* in England reports an acute infection of poultry due to *Streptococcus zooepidemicus* which became chronic after four weeks. Edwards *(57)* stated that all streptococcal infections of poultry that he has encountered have been due to the so-called animal group C types. Although some animal group C strains have been recovered from human throats, they were not associated with clinical illness *(93)*. A search of the literature revealed no reports of infection of fowls due to group A streptococcus strains.

Tuberculosis

Avian tuberculosis is widely distributed in poultry throughout the central and north central sections of the United States. This type frequently also infects swine, occasionally cattle and rarely man. It is most common in chickens and pigeons, although it does infect other species of fowl. Chickens are not susceptible to the typical human and bovine types of the tubercle bacillus. Atypical acid-fast bacilli have recently been found to produce lesions in chickens different from those produced by the avian type *(94)*. The question of the pathogenicity of avian tubercle bacilli for man has received much speculation. Feldman *(95)* reviewed the literature up to 1938 and concluded that although human infection does occur, it is rare. He further observed that many of the reported cases were inadequately or incompletely studied resulting in a questionable diagnosis of avian tuberculosis. Rich *(96)* reviewed the data available up to 1944 and noted "if progressive tuberculosis is ever produced in the human being by the avian tubercle bacillus it must be only rarely."

Karlson *et al. (97)* have found reports in the world literature of 25 cases in which avian tubercle bacilli have been isolated from human sources and adequately identified. These authors also report the isolation of avian bacilli from sputum and gastric washings of a patient with silicosis. His home was in a rural area where tuberculosis among chickens is prevalent. Bradbury and Younger *(98)* reported a case of pulmonary tuberculosis in a man from whom the organism was identified as the avian type on three occasions. This man had consumed one or more raw eggs a day for 30 years providing a possible source of infection. Avian

tubercle bacilli were isolated from a mediastinal lymph node of another patient *(99)*. A previous diagnosis of Hodgkin's disease had been made. Still another isolation was reported from a 50-year-old woman who had lived on a farm in Norway where tuberculosis of chickens was common *(100)*. Her illness was thought to be Boeck's Sarcoid. Two cultures isolated from human sputum and submitted to the CDC Tuberculosis Unit were found to be of the avian type *(101)*. Domingo and his coworkers *(102)* reported a case of tuberculosis in man caused by the avian type which was effectively treated with isoniazid.

In chickens the disease is characterized by its chronic course and by lesions in the liver, spleen, kidneys, ovaries, intestines and bone marrow. Large numbers of organisms are disseminated in fecal material. The bacilli are occasionally present in the eggs from tuberculous hens.

Feldman *(103)* made the following statement concerning the suitability of tuberculous fowl for human consumption: "When food markets are supplied from territories where tuberculosis is prevalent among chickens, the question of the suitability of the tuberculous fowl for human consumption is important. The problem is pertinent, not only because of the possible transmission of avian tuberculosis to human beings, but also because of the natural aversion of most people to food prepared from diseased animals."

Poultry tuberculosis becomes especially significant from the public health standpoint when it interferes with cattle TB eradication programs. Although usually resistant to invasion by the avian type, cattle are known to become tuberculin positive following exposure to the organisms. Since the eradication of bovine tuberculosis is dependent on elimination of all reactors, the disease in poultry is probably responsible for many cattle being classed as tuberculous on premises where healthy cattle are being sensitized by tuberculous chickens. In a review of the literature for causes of tuberculin positive reactions in nontuberculous cattle Paterson in 1956 *(104)* found that contact with avian tuberculosis was the most frequent cause.

Brucellosis

Natural outbreaks of brucella infection on poultry farms have been described in Italy by Fiorentine, in France by Dubois *(105)*, and in the United States by Emmel *(106)*. In a recent review of the literature on avian brucellosis, Anczykowski *(107)* concluded that the infection of domestic and some wild birds with brucella is more frequent and widespread than was formerly believed. The condition has been reported more frequently from Eastern Europe than from other parts of the world. He observed that among domestic birds, guinea fowl appear to be the most susceptible to infection. The symptoms in birds appear quite variable. In some, general debility, diarrhea, and paralysis are observed with high mortality; in others, no symptoms appear. Post-mortem examina-

tion shows enlargement of spleen and degeneration of liver and kidney with necrotic foci and enteritis. Emmel and Huddleson *(108,109)* were abl to produce infection in fowl by feeding naturally infected milk, portions of an aborted fetus, and cultures. They also reported the occurrence of natural infection in four flocks. Pagnini *(110)* attempted to infect chickens by giving them gelatin capsules containing brucella. He succeeded only when employing large numbers of organisms and concluded that chickens were not of great significance in the spread of brucellosis. Pavlov *(111)* reported that five of seven rabbits, placed with infected chickens, became infected and died in three months. Brucellae were isolated from the rabbits. None of three normal chickens and ten normal guinea pigs placed with the infected chickens showed evidence of infection. Eggs from chickens infected with massive doses of brucella were found to contain the organism only between the fourth and fourteenth day after infection.

The experiments of Felsenfeld and his associates *(112)* showed that intramuscular and intraperitoneal infections and feeding of brucella caused bacteriemia, fecal excretion of organisms and the appearance of significant serum agglutinin titers. Brucella was transmitted to normal chickens by feces from infected chickens. These investigators suggest the possibility of misinterpreting pullorum disease in flocks of chickens with brucella infection due to cross reactions observed with pullorum antigens. They have observed also the difficulty in detecting infected chickens during inspection due to the frequent absence of significant pathology.

Brucellosis in fowl is considered by Soviet investigators to be a minor source of infection for man *(113,114)*. However, since domestic and wild birds can become infected with brucella and shed the organisms, they may serve as vectors to other fowl, domestic animals and man, in areas where mingling with infected and susceptible hosts occurs.

Listeriosis

Listeria monocytogenes is a causative agent of sporadic cases of meningitis *(115,116,117)* in man and also has been isolated from the blood of patients with an infectious mononucleosis-like syndrome *(118)*. Finegold *et al. (119)* reviewed the literature summarizing reported cases of listeria meningitis. They point out that several cases of meningitis due to "diphtheroids," subsequently identified as listeria, have been reported. In a report of two additional human cases Williams and Hornung *(120)* also discussed the possibility of confusing *L. monocytogenes* with diphtheroids. Certainly according to current literature the prevalence of listeriosis in humans appears to be increasing. The largest number of reported cases for any one area of the United States has been from Louisiana *(121,122)*. It is possible that there is no actual increase in

incidence but rather an increase in awareness and ability to recognize the organisms.

In chickens it generally produces a specific septicemia with apparently few clinical symptoms. Thompson *(123)* reported a case in a hen in which marked pathological alteration of liver and kidney was observed. Necrotic lesions of the heart muscle and generalized edema may occur. Many other hosts are susceptible to spontaneous infection including the goat, sheep, cow, fox, guinea pig, and rabbit. Although encephalitic symptoms characteristic of listeriosis in some domestic mammals have not been observed in naturally infected chickens, Belding and Mayer *(124)* recently reported neurologic disturbance in a naturally infected turkey with recovery of listeria from the brain.

Distribution of the infection in man and animals appears to be worldwide *(118,123,125,126)*; outbreaks in chickens have been reported in the United States and England *(127,128,129)*.

Although no reports have been found to indicate direct transmission of listeria infection from poultry to man, the fact that both become infected is significant from a public health standpoint. Another significant factor is that *L. monocytogenes* apparently has a greater heat tolerance than most other nonsporeforming potentially pathogenic bacteria. Bearns and Girard *(130)* found that *L. monocytogenes* added to sterile milk in concentrations of 5×10^4/ml survived pasteurization by the holding technique (61.7° C, 35 min.). Listeria have been isolated from the egg yolk of fried eggs which had been experimentally infected before cooking *(131)*.

Tularemia

According to Burroughs *(132)*, grouse, sage hen, quail and horned owl have been found naturally infected with tularemia. At least two cases of tularemia *(133,134)* have occurred in man where the source of infection was attributed to pheasants dressed by the individuals. Apparently the disease does not exist or is very rare in domestic poultry since a search of the literature failed to reveal reports of its presence in chickens, turkeys or waterfowl.

Pseudotuberculosis

Pseudotuberculosis caused by *Pasteurella pseudotuberculosis rodentium*, is a disease occurring in birds, animals and man *(135,136)*. It is characterized by an acute septicemia of short duration followed by a chronic focal infection which gives rise to tubercular lesions in various organs. In fowl, outbreaks have been reported chiefly in turkeys *(137)* and rarely in ducks, pigeons and chickens. In man it appears to be rare but highly fatal. Meyer *(138)* refers to reports of 14 human cases, 11 of which

terminated fatally. According to Meyer the mode of transmission is not definitely known, but it is believed that *P. pseudotuberculosis*, widely distributed in nature and disseminated through infectious excretions of affected birds or rodents, attacks susceptible animals through the digestive tract as evidenced by primary involvement of the abdominal viscera in the majority of cases. Injuries of the skin may also serve as portals of entry. Direct or indirect contact may introduce the infection into a flock of birds. Hygienic conditions and prevention of exposure to infection are the usual prophylactic procedures.

Pasteurella multocida Infections

As the name indicates these organisms have more than one host. The many strains of this group change continuously in physiologic functions, antigenic structure, and pathogenic ability. Carter *(139)* stated that comprehension of the complex dissociation pattern of *P. multocida* is necessary to understand the epidemiology and pathogenesis of pasteurellosis. The total range of susceptible animal species is wide including man, rodents, herbivores, fowls and possibly carnivores but each host has its characteristic limitations beyond which it rarely goes in spontaneous disease, according to Meyer *(138)*. The first bacteriologically proved human case was reported by Brugnatelli *(138)* in 1913. Since that time human infections with *P. multocida* are being recognized more frequently *(140,141)*.

A review of the literature since 1930 by Schipper *(142)* revealed 39 reported human cases of which 20 were bacteriologically proved. Further evidence to support the occurrence of more frequent infection in man was presented by Needham *(143)*. He isolated *P. multocida* from 11 patients in the Mayo Clinic during 1947. Later Olsen and Needham *(144)* reported the isolation of this organism from an additional 26 cases bringing the total to 37 cases observed at the Mayo Clinic during the period from October 1946 to July 1951. Twenty-seven of the 37 patients were either farmers or members of a farmer's family. The source of material for bacteriologic study included bronchial secretion 17, sputum 17, empyema fluid 2, abscess of frontal sinus 1, appendiceal abscess 1, and purulent drainage from joint 1. All strains from these cases were found to be sensitive to low concentrations of penicillin. Although most of the patients had bronchiectasis, the authors consider *P. multocida* a probable "secondary invader." They emphasized, however, that the isolation of animal pasteurella in cases of human disease has a definite significance. In view of the relative prevalence of human infection they recommended that a more thorough search be made for this organism in infected material. Neter and associates *(145,146)* observed *P. multocida* wound infections in four children following bites by or contact with animals.

Numerous outbreaks of *Pasteurella multocida* infection (fowl cholera) in poultry have caused considerable losses. Due to the high incidence of fowl cholera throughout the world, poultry may well constitute one of the

largest natural reservoirs of *P. multocida*. Murray *(147)* stated that "while man may generally consume without harm fowls that are suffering from the disease, it is advised that their meat should under no circumstances be used as human food."

Anthrax

From time to time during the occurrence of anthrax outbreaks in domestic animals, questions have arisen regarding the possible role of wild birds and domestic fowls in the transmission of the disease. In 1912, Morris *(148)* in Louisiana conducted a series of experiments in an effort to determine whether carrion birds and chickens could serve as disseminators of anthrax. Although anthrax organisms were not found in the feces of buzzards after eating anthrax spores, they were obtained from the feet and beaks of buzzards kept in a cage 48 hours after feeding on an anthrax carcass. Morris also observed that it is the habit of buzzards to vomit a few hours after eating a meal of carrion flesh. Cultures of such vomited flesh yielded virulent anthrax organisms. He was unable to produce symptoms of anthrax in chickens but the spores were not destroyed in the digestive tract of chickens, and organisms were recovered from the feces 48 hours after they had eaten spore infected meat. From these experiments it appears that both the buzzard and the chicken may serve as a potential carrier of anthrax and as such play a part in transmission of the disease to domestic animals and even humans.

In a review of anthrax in birds Stafseth, *(149)* states that natural infection is extremely rare except in the ostrich. Several epizootics have been reported in this species. The disease may be acute or subacute. Sporadic cases of natural infection have occurred occasionally in ducks following exposure to infected swine or cattle.

Diphtheria

There is little evidence to indicate that diphtheria in poultry is of public health significance. One report has appeared in which chickens were thought to be the source of human infection. In a study of 256 cases of human diphtheria where contact with chickens was established, Litterer *(150)* reported two instances in which fowl harbored the virulent organisms. Virulent *Corynebacterium diphtheriae* was isolated from a child in the family who owned the fowls. No other reference to fowls as a host of virulent *C. diphtheriae* was found. In 1942, Frobisher, Parsons and T'ung *(151)* reported on the use of chicks in testing the virulence of *C. diphtheriae*. They found that 10 to 20 day old chicks are highly susceptible to the diphtheria toxin and that 50-100 units of antitoxin protected them. A virulent culture is indicated by death of the unprotected chick within 72 hours and survival of the protected chick.

Botulism

This disease is mentioned only because it produces the same condition in both man and domestic birds. It is a type of food poisoning caused by the ingestion of foods in which *Clostridium botulinum* has grown and produced a powerful neurotoxin. It is interesting to note that the four earliest reports of botulism (limberneck) in chickens in the United States were attributed to canned corn, green beans and apricots. In 3 of these instances, humans had eaten the same foods and died *(152)*.

Leptospirosis

Ingalls *(2)* considers leptospirosis as an occupational hazard to poultry dressing plant employees, although the birds are rarely, if ever, infected.

The predominance of poultry workers among the first patients found to have leptospirosis in the Detroit area led Molner *(153)* to study the problem in poultry dressing plants. It was found that rats were commonly in and around plants. Work tables were washed with Ringer's Solution in the morning after they were contaminated by rats during the night. Guinea pigs were infected with the washings and a clinical picture of Weil's disease was produced. No mention is made of isolation of the organism. This probable source of infection could be eliminated by adequate sanitation measures and rat control.

VIRAL DISEASES

Arthropod-borne Encephalitides

Eastern encephalitis (EE),* primarily a summer disease of birds, is transmissible to man and equines. In the human it is usually characterized by extensive inflammation and destruction of the central nervous system. It was first recovered in epidemic form in man by Fothergill *et al.* 1938 *(154)*; in the same year the first natural outbreak in birds was reported by Tyzzer, Sellards and Bennett *(155)* who encountered a fatal disease in ring-necked pheasants in Connecticut. Also in 1938, Fothergill *et al. (156)* observed natural infection in pigeons in Massachusetts. Beaudette and Black *(157)* reported natural

*In light of present knowledge, most virologists have dropped the word "equine" from this term.

outbreaks in pheasants in New Jersey from 1938 through 1946 except in 1940 and 1941. Additional outbreaks were reported *(158)* in Montana and one outbreak in Pennsylvania. It is well established that mosquitoes are the principal vectors of the virus between avian hosts *(159, 160, 161)*. Holden *(160)* found further evidence of direct transmission among confined pheasants.

The symptoms reported in pheasants include paralysis, staggering, head drawn over back, and anorexia. Death occurred in one or two days or the birds recovered slowly. The infection has been produced experimentally in chickens and turkeys. After experimental inoculation, Ten Broek *(162)* and Tyzzer *(163)* working independently showed that chickens may develop a viremia without visible signs of infection.

In man, children are most susceptible. A mortality rate of 65-70 percent has been reported in the age group under ten years.

The Western (WE)* and St. Louis (SLE) encephalitides are similar in geographic distribution and relative severity and in these ways are distinct from the Eastern type. They also infect a wide range of hosts. The extensive studies of Hammon have shown the important role that birds play in the epidemiology of these diseases. During the summer of 1941 Hammon *et al. (164, 165)* in Yakima Valley, Washington, found that *Culex tarsalis* mosquitoes were infected with the viruses of Western and St. Louis encephalitis and that approximately 50 percent of the chickens of the area had specific antibodies for these viruses, but no chicken epizootic had been observed. Experimental infection with either virus produced a viremia but no signs of illness. Evidence indicates that viremia of man is of short duration. Virus isolations from blood are rare. These authors also observed that *Culex tarsalis* fed predominantly on birds. The chicken mite *Dermanyssus gallinae* has been found infected with the St. Louis and Western type viruses *(166, 167)*. These findings have focused even more attention on the chicken as an important source of mosquito infection. In further studies in the Yakima Valley, Hammon *(168)* examined 576 sera from mammals and wild and domestic birds by neutralization test for antibodies against both viruses. Each of the viruses was positive in approximately 50 percent of sera from domestic fowl, 17-22 percent in wild birds, and only 8 percent from wild mammals.

The three important arthropod-borne encephalitides in the United States, EE, WE, and SLE, constitute what appears to be a group of natural epizootics among wild birds, transmitted by several species of mosquitoes and possibly other arthropod vectors. Domestic fowl can probably become part of the epizootic cycle and when infected would constitute an added reservoir for man and equines. According to Kissling *(169)* SLE virus seems especially likely to infect chicken flocks because of

* In light of present knowledge, most virologists have dropped the word "equine" from this term.

the frequency, duration and height of viremia found in experimentally infected chickens and the observation that chickens develop a high rate of SLE antibody during the course of a natural epidemic. EE, on the other hand, is known to cause high morbidity and mortality among commercially raised pheasants *(170)* considered a domestic fowl reservoir. The epidemiology of WE may include domestic poultry in a secondary role *(169)* depending upon the vectors' accessibility to them. The seriousness of human illness caused by the three viruses and evidence of symptomatic and asymptomatic infection in fowl are factors which should be considered in epidemic situations.

Japanese B encephalitis, another of the summer encephalitides, is prevalent in the Far East. It is characterized by varied clinical symptoms and caused by a virus similar in many ways to that of St. Louis encephalitis. Hammon *et al. (171)* demonstrated virus in mosquitoes caught in Japan. They were able to detect small amounts of virus in the blood of inoculated chickens. Subsequent studies *(172)* indicated wild birds as a potentially important source of mosquito infection. Extensive studies in Japan by Buescher and others have further clarified this natural history *(234, 235)*.

Newcastle Disease

Newcastle disease (avian pneumoencephalitis) of world-wide distribution in fowls was first recognized in man in 1943 by Burnet *(173)* who isolated the virus from a laboratory worker with conjunctivitis. Subsequently, reports have appeared of isolation of Newcastle Disease Virus (NDV) from eight cases of conjunctivitis in man *(174,175,176,177,178)*. Anderson *(174)*, 1946, in Australia reported two laboratory infections. An outbreak involving 17 cases of conjunctivitis among kitchen workers handling poultry was reported from Israel by Yatom *(179)*. Ingalls *(176)* encountered two cases of natural infection; one in a broiler plant operator and the other in a veterinary student. Both cases were related to recent contact with NDV infected chickens. More recently, Nelson *et al. (180)* reported the occurrence of an outbreak of conjunctivitis in poultry plant workers. Of the 40 cases, virus isolation was successful in four of ten acute cases. Specimens were obtained from the conjunctiva. They obtained a high SN index on specimens from employees in the plant showing no symptoms and observed that this may indicate resistance.

In a recent study on food poisoning bacteria in poultry and poultry products, Kyle, MacFadden and Gunderson *(25)* isolated Newcastle disease virus from chicken livers and spleens collected on the evisceration line of a commercial poultry processing plant in Nebraska. The relative frequency of cases of conjunctivitis occurring in workers on the evisceration lines of poultry processing plants prompted this study. These investigators studied three additional cases of conjunctivitis in humans from

systemic involvement in man. Mitchell and Walker *(184)* reported a laboratory infection, apparently acquired through the respiratory tract, which produced an influenza-like attack lasting about five days. NDV was isolated from bronchial mucus. There was no evidence of conjunctivitis. A case of acute hemolytic anemia with autohemagglutinative vascular phenomena was reported by Moolten and Clark *(185)* in which NDV was isolated from the patient's blood shortly after the acute phase of illness had subsided. The isolation of the virus from five additional cases of human infection was reported by Quinn, Hanson, Brown and Brandly *(186)*. These authors noted the possibility of man to man transmission of the disease in view of the demonstration of virus in saliva, nasal discharge and conjunctival sac washings. In one of their cases NDV was isolated from the urine. Kyle, MacFadden and Gunderson *(25)* observed that due to the inherent resistance and potential adaptability of the virus, it may well become a significant public health problem.

At the present time Newcastle disease is known to constitute an occupational hazard limited to persons engaged in poultry raising, processing, laboratory investigations and vaccine work.

Psittacosis-Ornithosis

Psittacosis-ornithosis, an apparent, or more frequently, an inapparent infection found in parrots, parakeets, canaries, pigeons, and many other birds is also communicable to man. It was formerly thought to be contracted only through association with psittacine birds; however, subsequent reports have incriminated ducks *(187)*, chickens *(188)* and turkeys *(189)* as a source of infection in man. In an effort to appraise the importance of the various known sources, Meyer *(190)* evaluated records available for 1945 to 1952. During this period 458 known human cases of psittacosis with 15 deaths were recorded. Of these the sources of infection of 35.3 percent were attributed to pigeons and domestic fowl. Ward *et al. (191)* reported 37 cases of respiratory disease associated with significant complement fixation titers to the psittacosis – LGV group in which chickens appeared to be the reservoir of infection. Of great importance was the discovery that visibly healthy birds harbor the virus and as shedders or chronic carriers distribute the infective agent. Irons *(189)* observed that the importance of common barnyard fowl in the spread of psittacosis is frequently overlooked. In a study of the problem in ducks on Long Island, during a period when psittacosis occurred in man in the area, 38 percent of 115 ducks and ducklings on nine different farms yielded a psittacosis-ornithosis virus similar to the pigeon strain *(192)*.

Irons *et al. (189)* described an outbreak of psittacosis in turkey dressers in a poultry plant in Texas. There were 22 cases and 3 deaths among 78 employees of the plant. All cases had been killing, picking feathers, or wrapping heads of turkeys. Few cases had been dressing chickens. It appeared that discharges from a group of turkeys were the

source of the outbreak. Clinical findings varied widely in severity of illness, from mild influenza-like attacks to fatal illness.

In a summary of outbreaks of psittacosis in Texas poultry plant employees, Irons *(193)* reports five outbreaks with at least 96 cases and seven deaths in plants at Giddings and El Campo, Texas, in 1948, 1951, 1952 and 1953. In the spring and summer of 1954, outbreaks of psittacosis occurred in employees of poultry plants in six other Texas towns with at least 200 cases and one death. All the patients had been dressing turkeys. Psittacosis virus of unusual virulence was recovered from turkeys in the plants and on the farms on several occasions.

Pate, Boney and Delaplane *(194)* describe the characteristics of ornithosis as it occurred in naturally and experimentally infected turkeys. They found that turkeys of all ages are susceptible to infection but the mortality is greater in young birds. Davis *et al. (195)* were unable to recover ornithosis virus from eggs laid by turkey hens in the viremic stage of the disease.

Pigeons have been incriminated frequently in outbreaks in man and in some instances chickens have been involved also. A human infection was traced to a chicken in New Jersey. Four of 31 birds examined harbored psittacosis virus resembling the pigeon strain. Study of two other human cases attributed to pigeons revealed that the infected birds were caged over a chicken pen; pigeon-psittacosis virus was recovered from the organs of two of the chickens. Determination of the extent of spontaneous psittacosis in chickens depends upon the development of a simple serological test for mass examination of barnyard fowl *(192)*. An indirect complement-fixation-inhibition test *(196)* has improved detection of the disease in chickens.

Benedict and McFarland *(197)* describe a technique for testing dermal hypersensitivity of fowl infected with ornithosis. A simple skin test was developed using ornithosis antigen which offers promise in mass testing of flocks.

Recent studies of Volkert and Matthiesen *(198)* indicated that an antigenic relationship exists between ornithosis virus and *Bacterium anitratum*. They further showed that ornithosis infection in humans can cause production of antibodies reacting with *B. anitratum* antigens *(199)*. Apparently this phenomenon and its application to the study of serums from birds have not been studied.

A case of atypical pneumonia in a poultry dealer has been reported by Duncan, Thomas and Tobin *(200)* in England. Virus of the psittacosis-ornithosis type was isolated from throat washings. Ward and Birge *(201)* describe a case of psittacosis in the owner of a pheasant ranch.

An investigation by the Oregon State Board of Health in collaboration with the Communicable Disease Center and the George Williams Hooper Foundation revealed that a severe epizootic of ornithosis occurred on several turkey raising farms in Oregon in 1956. Following the disposition of turkeys from the infected flocks, human cases occurred on two farms.

in two rendering plants processing dead birds, and in three poultry processing plants handling well birds from the infected flocks. From January to May 1956 a total of 86 human cases were reported in Oregon, all due to turkey exposures. One patient died and ornithosis virus was isolated from lung tissue obtained at autopsy.

Table 3 lists outbreaks of psittacosis attributed to poultry by year from 1948 through 1957. It is evident from the number of cases in the

Table 3

OUTBREAKS OF PSITTACOSIS ATTRIBUTED TO POULTRY
1948-1959

Year	State	Outbreaks	Human Cases	Poultry Contact
1948	New York	1	19	Duck Processing
1948	Texas	3	85*	Turkey Processing
1951-52	Texas	1	44**	Turkey Processing
1952	Illinois	1	5	Chicken-farm
1953	Texas	2	30	Turkey Processing
1953	Illinois	1	45	Chicken-rural
1954	Illinois	1	32	Chicken-rural
1954	New Jersey	1	5	Turkey Processing
1954	Texas	10	201	Turkey Processing
1955	Illinois	1	16	Chicken-rural
1955	Iowa	1	3	Turkey Processing
1956	Oregon	1	86	Turkey Processing
1956	Virginia	1	21	Duck-farmer & breeder
1956	Texas	1	34	Turkey Processing
1956	Connecticut	1	6	Chicken Processing
1957	Oregon	1	3	Turkey Processing
1957	Pennsylvania	1	3	Mixed poultry Processing
1957	California	1	1	Pigeons and squabs (handling and eating)
1958	Virginia	1	2	Duck Farm
1958	Wisconsin	1	1	Turkey Farm
1958	Wisconsin	1	2	Turkey Processing Plant
1958	Oregon	1	1	Poultry Processing Plant
1958	California	1	1	Pigeons and Chickens
1959	Maine	1	1	Turkey Farm
1959	California	1	1	Game Birds

* 7 deaths
** 4 deaths

(NOVS)

literature and the official reports, as well as the severity with which the disease is often associated in man, that drastic measures are warranted to quickly control outbreaks in poultry. A complicating factor is that on many occasions asymptomatic infections with ornithosis virus have been determined in various species of fowl. The disease can smolder, therefore, in a flock for variable periods of time before it manifests itself by morbidity and mortality.

Data assembled from CDC records *(202,203)* indicate that during the four-year period 1954-1957* there were 1,682 reported human cases of psittacosis-ornithosis. Of these, 359 (21.4 percent) were determined to be due to poultry exposure, 587 (34.9 percent) due to parakeets and other pet birds and 736 (43.7 percent) sources of infection undetermined.

During two of the four years, 1954 and 1956, association with large outbreaks of turkey-ornithosis accounted for 41.6 percent and 22.0 percent, respectively, of the total reported human cases. On the other hand, in 1955 and 1957 when explosive human disease due to poultry processing did not occur, poultry exposure accounted for 2.9 percent and 1.1 percent of all cases respectively.

Steele and Scruggs *(204)* state that "the reduction in incidence of human psittacosis-ornithosis depends on the control of the disease in parakeets and turkeys. These two categories of birds account for most of the 1,733 cases of psittacosis in man reported in the United States during the period 1951 to 1956." Data presented in their analysis point up the fact that human infections due to turkey exposures were explosive and confined to groups of persons handling diseased birds, while those attributed to parakeets were more widespread and sporadic.

FUNGUS DISEASES

The mycotic infections associated with fowls probably constitute a minor hazard to poultry workers. Those which will be mentioned here are aspergillosis, favus, thrush and histoplasmosis. Emmons *(205)* stated that fungus diseases of poultry are of little danger to man unless there is heavy exposure and the individual has other predisposing factors.

*These data are based on reports submitted to the CDC and the NOVS. It is assumed that the epidemiologic reports received by the CDC are included in the total of cases submitted to the NOVS.

Aspergillosis

Aspergillus fumigatus is especially pathogenic for birds but rarely causes aspergillosis in man. The disease is common enough in turkeys, pigeons, chickens and ducks *(206,207,208)* to be of some economic importance. In young chicks it frequently occurs in epidemic form and is known as brooder pneumonia *(209,210)*. The disease may be localized or generalized but usually occurs in the lungs and air sacs. Ophthalmic aspergillosis has been observed by Moore *(211)* in poults and by Hudson *(212)* and Reis *(213)* in chicks.

The infection appears to be acquired following inhalation of spores from moldy grain or litter. In man observations have indicated that infection most frequently follows exposure to air carrying many spores *(214)*. Infections of the external ear have been attributed to *Aspergillus* sp. *(215)*. However, the recent studies of Singer, Freeman and Hardy *(216)* on otitis externa indicate that this fungus is of minor importance. While *A. fumigatus* may be isolated readily from soil, under certain conditions fowls with acute aspergillosis could serve as a potential source of direct or indirect exposure for man.

Favus

Favus is a type of ringworm caused by several species of the genus *Trichophyton*. The agent of favus or white comb in poultry is *Trichophyton gallinae*. In his excellent review of mycotic diseases of animals Gordon *(217)* stated that despite the numerous references to the disease in American literature, there have been only two instances in which an organism has been cultured which could be identified as *T. gallinae* according to published reports. It has been isolated from an infected human being in France *(218)*. A recent case of favus in a child in Puerto Rico resulted in isolation of *T. gallinae* from the patient and from chickens on the farm where she resided *(219)*.

Thrush

Thrush (candidiasis, moniliasis) is another fungus infection that has caused high mortality in poultry flocks, especially young birds. It is caused by the yeast-like organism *Candida albicans*. The disease has been observed in chickens, pigeons, turkeys, pheasants, guineas *(220)* and other birds and in man. In poultry, lesions are localized in the mucosa of the upper alimentary canal and appear as whitish ulcers or pseudo-membranes in the crop and gizzard.

In man *(221) C. albicans* may cause infections of the mucous membranes of the mouth and vagina; infections of the skin and nails; systemic infections or a mild broncho-pulmonary infection.

No reports have been found indicating transmission of the disease from infected fowl to man although this may occur.

Histoplasmosis

Although no reports could be found in the literature of natural histoplasmosis infection in fowls, the association between isolation of *Histoplasma capsulatum* from soil and the presence of fowl excreta in the soil is significant and has been confirmed. Emmons *(222)* isolated the fungus from soil in 31 locations in Virginia, Maryland and West Virginia. Of these, 17 were soils from chicken yards and inside or adjacent to chicken houses. Furcolow *(223)* reviewed 41 human epidemics and found that in 23, or 56 percent, bird excreta were involved. He further found that in areas of 70 - 90 percent histoplasmin sensitivity among humans, 27 percent of soils obtained from chicken houses contained *H. capsulatum*. In buildings occupied by animals other than chickens, 4 percent of the soils were positive; buildings occupied by humans, 1 percent of soil positive; wooded areas, stumps and river banks, 5 percent positive; caves, silos and storm cellars, 3 percent positive. No histoplasma were isolated from chicken houses in areas where the histoplasmin sensitivity of humans was below 70 percent.

Bird excreta may serve as enrichment for the growth of histoplasma, or some other yet undefined association may exist between fowls and *H. capsulatum*.

PARASITIC DISEASES

Dermanyssus gallinae Infestation

Dermanyssus gallinae, the poultry mite, frequently causes irritation and an itching dermatitis in poultrymen *(224)*. As previously pointed out these mites have been found infected with St. Louis and Western encephalitis virus *(166,167)*.

Toxoplasmosis

According to Manwell *et al. (225)* toxoplasmosis is one of the least understood of human and animal infections. Epizootic outbreaks causing high mortality among chickens have been reported in Europe *(226,227, 228)*. It is still uncertain whether birds are naturally infected with strains of toxoplasma infective for mammals. Manwell *et al. (225)* found that

certain species including the duck, chicken, pigeon, canary, and wild birds are highly susceptible to experimental infection with a toxoplasma strain of human origin. Harboe and Ericksen *(229)* attempted to produce systemic diseases in chickens by infection with a chicken strain and a human strain of toxoplasma. They failed to produce the type of disease observed in spontaneously infected chickens.

In Uruguay, Cassamagnaghi *(230)* reported that the enzootic form of toxoplasmosis in young canaries and pigeons was artificially transmissible to rabbits. He cautioned that these two avian hosts should be regarded as potential sources of infection for man and animals. Sparapani *(231)* found toxoplasma in material from ovaries of three hens and emphasized the need for thorough cooking of eggs from infected fowl.

Gibson and Eyles *(232)* recently reported toxoplasma infection in animals associated with a case of human congenital toxoplasmosis. The parasites were recovered from the case and from 7 of 35 cats; 2 of 3 ducks; 3 of 7 chickens; 1 of 16 pigeons and 7 of 121 mice obtained from the patient's immediate neighborhood. Since, with the exception of wild birds, all vertebrates in the area showed some degree of infection with toxoplasma, the authors suggest that toxoplasmosis should be regarded as a zoonosis in which man is only one of several normal vertebrate hosts.

Sabin *(233)* stated that "when the incidence of toxoplasmic infection has been determined among the mammals and birds in the human environment, the role of various species and the modes of transmission involved in perpetuating this protozoan in nature should become an interesting and profitable field of study."

COMMENTS

Compulsory inspection of poultry in interstate commerce in the United States has been in effect in most processing plants since January 1, 1959. This service should exert a profound beneficial effect on the quality of poultry meat marketed in the United States. Diseased poultry detected by ante-mortem or post-mortem examination and poultry contaminated by unsanitary processing procedures will be condemned in the inspected establishments. The complete safety of poultry products, however, will depend on ultimate eradication of disease conditions common to poultry and man from the poultry flocks themselves. According to Brandly *(3)* "eventual eradication of transmissible diseases common to birds and man require, at the onset, thorough elucidation of epizootiology together with adequate and often needed improvements in detection and diagnostic methods. These knowledges and skills, supplemented by sound long-range perspectives and practices and abetted by persistent educational programs must inevitably lead to success."

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